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A COOPERATIVE
Study Level-of-Growing-Stock
in Douglas-fir

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strong factors in management decisions.

The Pacific Northwest Forest and Range Experiment Station is serving as coordinator for a cooperative study of levels of growing stock. Private industry and educational and governmental agencies are participating, both in field installations and by representation on a level-of-growing-stock committee under Experiment Station auspices. The original study plan, prepared by Weyerhaeuser Co., has been expanded and adapted to the use of all cooperators and is available from the Experiment Station.

This Douglas-fir study is designed specifically to examine (1) cumulative wood production, (2) tree size development, and (3) growth-growing stock ratios. This paper gives fundamentals of the work plan and a description of existing installations.

DESCRIPTION OF EXPERIMENT

A single experiment consists of eight thinning regimes, plus unthinned controls, applied to twenty-seven 1/5-acre plots, with three plots per treatment in a completely randomized design. Experience to date indicates that a gross area of approximately 9 acres is required for the plots and 30-foot surround. Uniformity of site on a single installation is essential. Interaction of site quality and treatment can be evaluated by having installations replicated at least twice on each site. A cooperative effort has made this replication possible.

All 24 treated plots are thinned initially to the same density to minimize the effect on results of variations in original density. Density to be achieved by this "conditioning" thinning is controlled by average diameter (weighted by basal area) and number of stems according to the formula:

Average spacing in feet = $0.6167 (\text{av. diam.}) + 8$. Sample solutions of this equation give:

Average diameter (inches)	Trees per acre (number)	Basal area (square feet)
3	449	22.0
4	398	34.8
5	355	48.2
6	318	62.4

This equation assumes an initial spacing of 8 feet for trees 4.5 feet tall, 100 trees per acre with average d.b.h. of 20.9 inches at harvest, and an interim linear relationship between spacing and d.b.h.

In addition to achieving a common density, the objective of the initial thinning is to leave a stand as evenly spaced as possible. We are measuring the effect of different thinning regimes in stands alike at the start.

Well-formed, uniformly spaced, dominant trees at the rate of 80 per acre, or 16 per plot, are designated as crop trees prior to initial thinning. Each quarter of a plot must have no fewer than three suitable crop trees--another restriction on uniformity of stands chosen for the study.

The interval following initial thinning permits the trees to adjust to the common density of the plots. If the dominant trees are from 20 to 40 feet in height (a requirement for choice of a stand), the stand is assumed to be vigorous and sufficiently adaptable to recover rapidly from the effects of any competition existing before initial thinning.

Interval between initial thinning and the first treatment thinning and between all succeeding thinnings is equal to the time required for crop trees to grow an average of 10 feet in height.

As far as possible, kind of thinning is eliminated as a variable in the treatment thinnings through several specifications:

1. No crop tree may be cut until all noncrop trees have been cut (another tree may be substituted for a crop tree damaged by logging or killed by natural agents);

2. The average diameter of cut trees should approximate the average diameter of trees that are available for cutting; and
3. The diameters of cut trees should sample the full diameter range of trees available for cutting.

The eight thinning regimes tested differ in the amount of basal area allowed to accumulate in the growing stock. The amount added for a particular treatment to that left after the previous thinning is a predetermined percentage of the gross increase found on the unthinned plots since the last thinning. As used in the study, the control plots may be thought of as providing a "local yield table" for the study area. The thinning regimes are shown in table 1.

Table 1.--Levels-of-growing-stock study treatment schedule, showing percent of gross basal area increment to be retained in growing stock

Thinning	Treatment							
	1	2	3	4	5	6	7	8
- - - - - Percent - - - - -								
Initial	--	--	--	--	--	--	--	--
1st	10	10	30	30	50	50	70	70
2d	10	20	30	40	50	40	70	60
3d	10	30	30	50	50	30	70	50
4th	10	40	30	60	50	20	70	40
5th	10	50	30	70	50	10	70	30
6th ¹								

¹ Evaluate results for possible further treatment.

Clearly, this range of treatments will explore the ability of Douglas-fir to respond to varying degrees of release as the stands pass through the critical developmental stages. At the conclusion of the study, densities should range from near normal basal area to very low levels where all trees grow somewhat like open-grown trees. The range in yield, tree size, and growth-growing stock ratios should permit foresters to choose regimes that will satisfy any particular objective of management.

EXISTING INSTALLATIONS

Lands of site quality II to IV are represented by six installations to date. A few statistics for each study area are summarized in table 2. Statistics apply to the stand left by the conditioning thinning, except where otherwise indicated.

Table 2.--Statistics of the residual stands on levels-of-growing-stock study areas

Study area	Site index	Age	Average d.b.h.	Trees per acre-all species	Basal area per acre	Average height crop trees
	Feet	Years	Inches	Number	Square Feet	Feet
Skykomish	140	¹ 16	5.1	358	50.8	44
Hoskins	160	¹ 13	5.0	345	47.6	42
Rocky Brook	110	21	4.0	400	35.7	28
Clemons	² 180	19	4.1	395	35.8	31
Francis	180	19	3.8	405	31.0	25
VN-1 400 Line	170	12	1.9	(3)	(3)	14

¹ At breast height.

² Estimated.

³ Not available.

Skykomish Tree Farm

The Skykomish study, on the Skykomish Tree Farm of Weyerhaeuser Co., was the first installed (fall 1961) in the regional effort. Many of the details of the standardized work plan were worked out on this installation. The area occupies a north-facing slope along Youngs River, which is a tributary to the Skykomish River, near Sultan, Wash.

The study is in a natural stand of mixed Douglas-fir and western hemlock. Douglas-fir was favored in the initial thinning, but the leave stand still has considerable hemlock. Alder was eliminated by girdling or felling. The original stand was heavily stocked and not quite as uniform as required by specifications in the present work plan.

In spite of what appeared to be severe opening up by thinning, the stand survived the 1962 Columbus Day wind-storm with little loss and, in general, appears very thrifty 2 years after treatment.

Hoskins

The Hoskins study is a joint effort of Oregon State University and the Oregon Forest Research Laboratory, and was made possible through the provision of land and timber by T.J. and Bruce Starker.

The area is just west of the Coast Ranges summit near Hoskins, Oreg., about 25 miles northwest of Corvallis. The aspect is southerly, with slopes from 15 to 55 percent.

Figure 1.--Study area near Hoskins, Oreg. A, control plot; B, treatment plots.



This natural stand is outstanding in uniformity of age and stocking. Little effort was required to mark all plots for the conditioning thinning so that basal areas varied no more than ± 3 percent around the general mean; at the same time, average diameters were kept within ± 10 percent of the mean.

This site II stand will afford an opportunity to examine management possibilities on land that offers great returns from management. Figure 1 illustrates stand conditions on the Hoskins area.

Rocky Brook

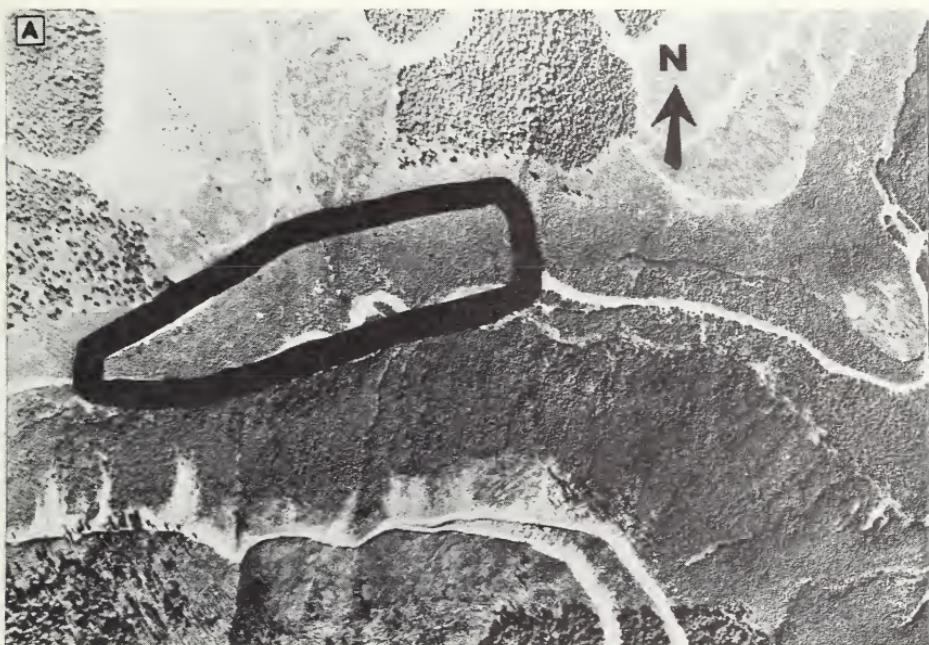
The U.S. Forest Service, Region 6, working with the Pacific Northwest Forest and Range Experiment Station, has installed a study area on the Hoodspout Ranger District, Olympic National Forest, near Brinnon, Wash. This site IV stand is representative of much of the land administered by the Forest Service and other public agencies. Little is known of the economic and silvicultural advantages of stand treatment on poor quality lands; yet, the public agencies are committed to strive for maximum use of these lands. This study will provide guides for future action.

The Rocky Brook stand is a plantation with plentiful natural fill-in. Installation was difficult because of several small foci of *Poria weiri* root rot discovered throughout the stand. Additional plots were established to replace plots containing *P. weiri*.

The stand occupies a streamside terrace near the bottom of a deep, glaciated canyon. Aspect is southerly, but the area is shaded by a high, steep ridge to the south. This shade and the rocky, infertile soil contribute to the low site quality.

The Rocky Brook area exemplifies stand density and uniformity sought in candidate areas (fig. 2).

Figure 2--The Rocky Brook study area, located on the Hoodspur Ranger District, Olympic National Forest, near Brinnon, Wash. A, Aerial view (scale, 1 inch = 1,000 feet); B, treatment plot.



Clemons Tree Farm

This installation was made in a 17-year-old plantation. It occupies a very high site near Blue Mountain about 10 miles west of Oakville, Wash., on the Clemons Tree Farm of Weyerhaeuser Co. Plots are grouped on top of a low ridge with generally moderate slopes. Because the plantation has been badly browsed by mammals and was suppressed by bracken in its early years, site index cannot yet be accurately determined. In the preparatory thinning, the majority of the trees removed were deformed or of poor quality because of browsing or damage from the 1955 freeze.

The study includes two control plots installed 1 year previously for another experiment. Current growth on these two plots is 11 square feet of basal area per year on 500 trees larger than 2.3 inches. Average diameter increased a little more than 0.4 inch in the year between measurements. Many trees felled in thinning had 4-foot leaders. Obviously, the growth capacity of Douglas-fir on this site is exceptional.

Francis

The Washington State Department of Natural Resources made a determined effort to locate a suitable stand for the study and found a fine plantation on a ridgeline with deep, though rocky, soil in the Willapa Hills near Raymond, Wash. Apparently, abundant moisture during the growing season is responsible for the high site quality. Growth on this area, like that on the Clemons area, seems exceptional, with some trees having 4-foot leaders (fig. 3).

Figure 3.--Washington State Department of Natural Resources study area in the Willapa Hills near Raymond, Wash. A, Treatment plot after thinning; B, treatment plot after thinning, with control plot in background.



VN-1 400 Line

This installation by Crown Zellerbach Corp. has only two replications per treatment instead of three as specified by the work plan. After an intensive search of the corporation's lands, their research staff selected a plantation on the Edward P. Stamm Tree Farm, about 3 miles southeast of Vernonia, Oreg. This plantation was the only Douglas-fir stand on the corporation's lands in northwestern Oregon that met the stringent uniformity-of-stocking specifications in the work plan. The area was not large enough for the full 27 plots, but the corporation decided, after agreement with officers of the level-of-growing-stock-studies committee, to install a two-replication study, using 18 plots. Though a considerable risk of loss of experimental sensitivity was thus assumed, protection, stand, and site factors promise to hold these losses to a tolerable level.

The stand is below minimum size now, but will be ready for the calibration thinning in 2 years, when the trees will be over 20 feet tall. The present unthinned stand totals 460 trees per acre. The basal area of trees 1.5 inches and over d.b.h. is 5.3 square feet.

NEED FOR MORE STUDY AREAS

It is reassuring to have four installations of the study on site II, especially since they are widely spaced geographically. This diversity will add much confidence to any recommendations made about management of these highly productive stands.

We hope that the experiment can be replicated at least twice on lands of each quality from I to IV to make the treatment results generally applicable. At present, there is only one installation each on site classes III and IV and none on site I.

The study requires stands--natural, seeded, or planted--20 to 40 feet in height, of uniform stocking, with an average of no more than four or five whorls of dead limbs (evidence of no serious previous competition). Requisite stand characteristics are illustrated by figures 1 to 3.

Stands of the required size, uniformity, and area are rare. Therefore, the authors would welcome suggestions from anyone regarding areas that might be suitable for this study. If the study is on land representative of their holdings, cooperators may expect to derive positive guides to timber management (whatever their objectives may be) in return for their investment.

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